# HIBERNATING ICHNEUMONIDAE OF OHIO (HYMENOPTERA)[1]

CLEMENT E. DASCH

*Department of Biology, Muskingum College, New Concord, Ohio 43762*

ABSTRACT

Hibernation of the adult insect occurs infrequently in the Hymenoptera. Thirty-nine species of parasitoid Ichneumonidae, representing thirteen genera and three subfamilies, were collected as hibernating adults in Ohio. Of 5,275 hibernating specimens examined, all but one were female. Hibernating specimens were collected from mid-October to mid-April, 1965–1970. Deep ravines, north-facing slopes, and low-lying ground where humidity and temperature fluctuations are minimal represented the most favored hibernation locations. Six types of hibernacula were examined, with sites beneath the loose bark of fallen trees favored by the most species and the largest numbers of specimens. Tables summarizing the distributional and ecological data and a key to the hibernating species are provided.

## INTRODUCTION

Most holometabolous insects overwinter in temperate regions as pupae or larvae, less often as eggs or adults. Among the Hymenoptera of Ohio, many species of ants, female wasps (*Vespa, Polistes*), and female bumblebees (*Bombus*) hibernate as adults. The adult females of some species of the parasitoid Ichneumonidae, particularly Ichneumoninae, also hibernate.

Only a few studies have been made of hibernating Ichneumonidae. Townes (1938) found 25 species hibernating in several localities in northeastern United States. In addition to listing the species collected, he discussed the preference of several species for specific hibernating sites. Seyrig (1924) collected 62 hibernating species in France and listed the hibernacula in which each was found. Hancock (1923, 1925) collected 20 species in hibernation in England. Raskitzyn (1960) collected 50 species in hibernation in the Moscow and the Kalinin regions of the U.S.S.R. Heinrich (1960–62) reports that all species of the ichneumonine genera *Aoplus, Chasmias, Eutanyacra, Exephanes, Hoplismenus, Ichneumon, Spilichneumon, Stenichneumon, Thyrateles*, and some species of *Diphyus* hibernate as adult females. Several of the species in these genera are known to occur in Ohio, but have not been discovered in hibernation in the state.

Thirty-nine species of Ichneumonidae, representing thirteen genera and three subfamilies, were collected in hibernation in Ohio during this study. In addition, three other species were collected in southeastern Michigan and two others in western New York. These species are included in this paper, based on the assumption that they probably will be found eventually in Ohio.

The adult stages of most insect species are not readily available during the winter months in temperate regions. In contrast to this are the hibernating Ichneumonidae, which offer considerable potentiality as research material in this area. Females of the Ichneumoninae are available from October through June, at a time when teaching and research in colleges is at a peak and the availability of other suitable insect study material is at a minimum. The classification of the Ichneumoninae, being based principally on morphological studies and rather limited biological and ecological data, still has many uncertainties. Senior students at Muskingum College and I are presently comparing the traditional classification of the group with information gained through disc electrophoretic studies of total proteins, and the enzymes esterase, alkaline phosphatase, peroxidase, and catalase. Cytological studies have been initiated recently to gain further insights into the evolutionary mechanisms involved in speciation in this group. Because re-

[1]Manuscript received June 6, 1970.

gional populations, subspecies, numbers of species within several of the genera, and varying levels of relatedness at the generic and subfamily levels exist among these species, they serve as a useful tool for comparing biochemical relationships with more traditional morphological means. My students have used these species in comparative morphological studies of the female internal reproductive system and of the head capsule. Also, as the females are impregnated before entering hibernation, the sperm stored in the spermatheca may be used to effect fertilization of the egg, permitting examination of early embryonic development.

Living material may be stored for several months in vials and plastic bags under refrigeration, requiring only that the humidity in the containers be kept high enough to prevent dehydration of the specimens. Specimens may also be held for months at room temperature by supplying ample water and nutrients in the form of a 50/50 honey/water mixture.

This paper is intended to serve a two-fold purpose. A taxonomic key is presented for the identification of those species of Ichneumonidae that have been collected in hibernation in Ohio by the author. A tabulation of the ecological

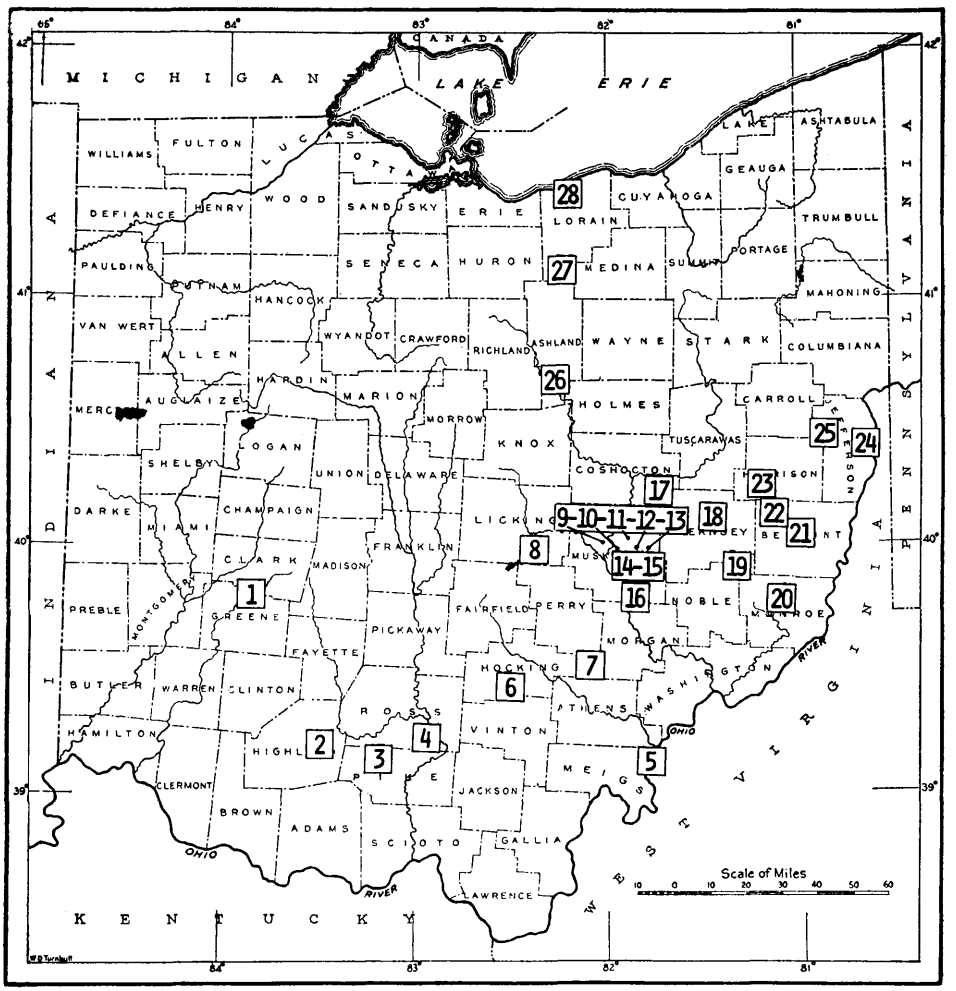


FIGURE 1. Map of Ohio counties with collection-site reference numbers.

sites most preferred by each of these species in Ohio is also included, to add to our knowledge of the ecology of these species and to facilitate the collecting efforts of others.

## METHODS

This paper summarizes the studies made during 64 collecting trips from 1965–1970, totalling approximately 350 hours in the field, at 28 collection localities in Ohio, two localities in southeastern Michigan, and three in western New York. These trips were made during periods of favorable weather from mid-October through mid-April when snow-cover was lacking.

A thorough search was made at each locality visited for likely hibernation sites. This involved the stripping of bark from dead standing and fallen trees and stumps, a search within and under decaying logs, under moss, under rocks, and an examination of the branches and needles of conifers and the bases of grass tussocks.

Collected specimens were placed in plastic snap-cap vials and returned to the laboratory for identification. The specimens were stored in the vials, placed in plastic bags, and held at normal refrigerator temperatures. The placing of dampened paper toweling in the plastic bags prevented dehydration of the specimens.

Identification of the species was made through the use of Heinrich's keys to the Ichneumoninae (1960–62). Types of the Cresson, Cushman, and Viereck species were examined at the U. S. National Museum and the Academy of Natural Sciences of Philadelphia. Dr. Gerd Heinrich confirmed the identification of a number of the more difficult species and several which he had described.

Large numbers of the specimens have been used in the biology laboratory of Muskingum College for the studies cited here. Specimens of all the hibernating species collected in Ohio are in the author's private collection of Ichneumonidae at New Concord, Ohio.

## HABITS

Those Ichneumoninae which hibernate include a diversity of species ranging in size from 5 to 20 mm. My collecting experience supports Heinrich's (1960–62) view that the majority of these species have but one generation per year. The males die during the early fall and do not enter hibernation. The impregnated females enter hibernation from middle to late October and remain inactive until early April, breaking hibernation when air temperatures rise to averages consistently above freezing. The females, upon leaving hibernation, seek out either the larvae or newly formed pupae of Lepidoptera for oviposition (Heinrich, 1960–62; Peck, 1964). Although the author has a private collection of approximately 150,000 specimens of Ichneumonidae, he has not been able to collect, either by hand-net or by Malaise trap, several of the species that have been taken in numbers in hibernation. This may be due to the limited but swift flight of the Ichneumoninae and their habit of searching for hosts by crawling over low herbs and on the ground. The earliest date on which hibernating Ichneumonidae were collected in Ohio was October 17, 1970, and the latest date was April 18, 1970.

Hibernation sites chosen by the ichneumonids were restricted to certain clear-cut types of locations, judged on the basis of the number of specimens collected in each site. Most of the hibernacula were located on north-facing slopes, at the bottom of steep ravines, or in low-lying areas excluded from direct sunlight, where the humidity remains high and the temperature undergoes only limited fluctuations during the hibernation period. Only a few specimens were obtained from hibernation sites located on ridge tops, in open fields, or in sites exposed to extensive drying or temperature changes, though such sites were also searched. Even within favorable locales, most of the ichneumonid individuals were found in

particular logs or stumps, while other, similar-appearing sites were often completely devoid of hibernatants. This "clustering" habit appeared to be very characteristic of several of the more common species, such as *Aoplus confirmatus*, *Hoplismenus morulus*, *Ichneumon ultimus*, *I. heterocampae*, and *Orgichneumon calcatorius*. The reason for the "clustering" habit is unknown, but is presently under investigation in our laboratory at Muskingum College. Small microclimatic differences that are detectable by the ichenumonids may exist among sites in an area that appear superficially alike to the observer, or pheromone secretions deposited by early arrivals among the wasps may mark the site for later arrivals.

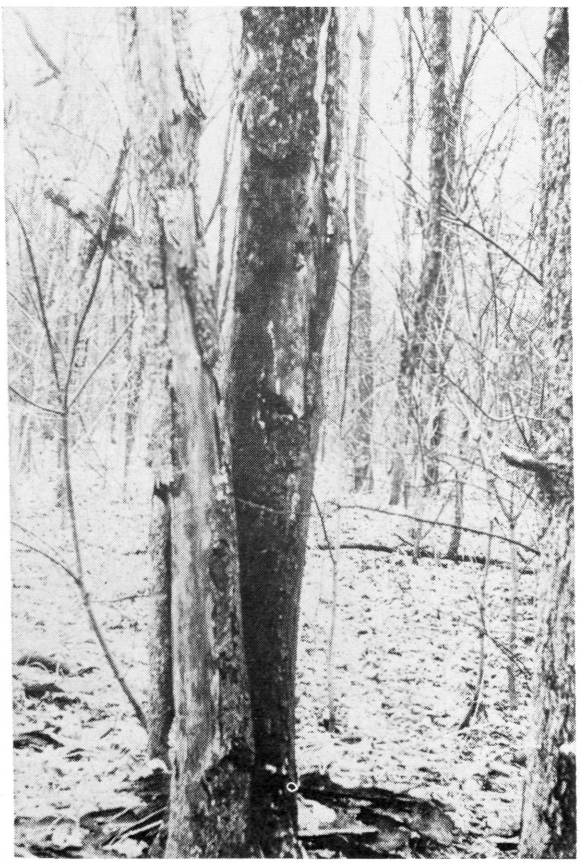

FIGURE 2. Standing dead tree with loose bark. Typical hibernation site of *Hoplismenus m. morulus*.

For descriptive purposes, the hibernacula have been classified into six main types, as listed in Table 1. The variety of hibernacula actually form nearly a continuum, necessitating a somewhat arbitrary treatment in the classification. Figures 2–7 show several of the ecological sites listed in Table 1.

Although there was some diversity in the types of hibernating sites selected by most species, a preference for particular kinds of hibernacula was evident in those species most frequently collected. *Ichneumon ultimus*, the most frequently collected species in this study, although found most regularly in "punky," well-

FIGURE 3. Fallen log with loose bark, lying at base of north-facing slope. Typical hibernation site of *Ichneumon centrator*, *I. fuscifrons*, and *Orgichneumon calcatorius*.

FIGURE 4. Log in well-advanced state of decomposition. Typical hibernation site of *Ichneumon ultimus* and *I. heterocampae*.

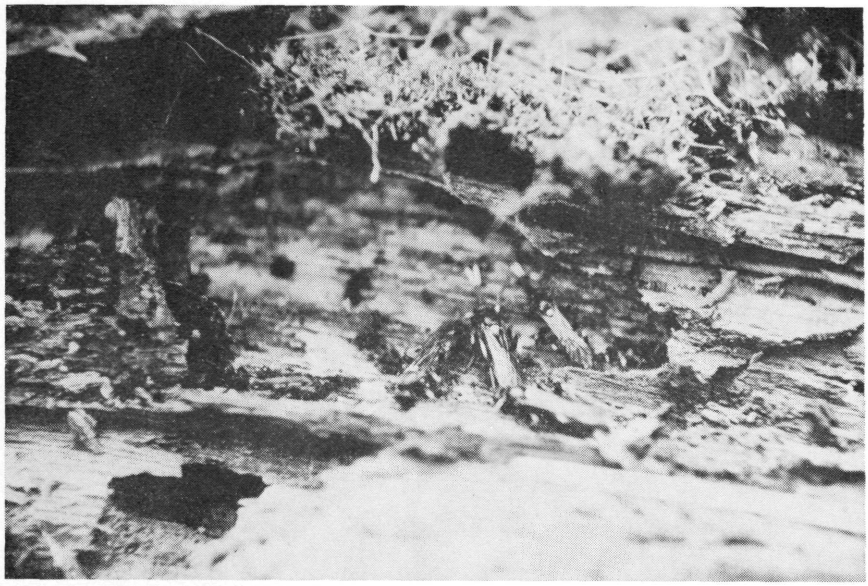

FIGURE 5. *Ichneumon ultimus* and *I. heterocampae* in partly decomposed, moss-covered log.

FIGURE 6. Moss-covered log. Typical hibernation site of *Ichneumon grandisops*, *I. inurbanus*, *I. heterodon*, and *I. pumiliops*.

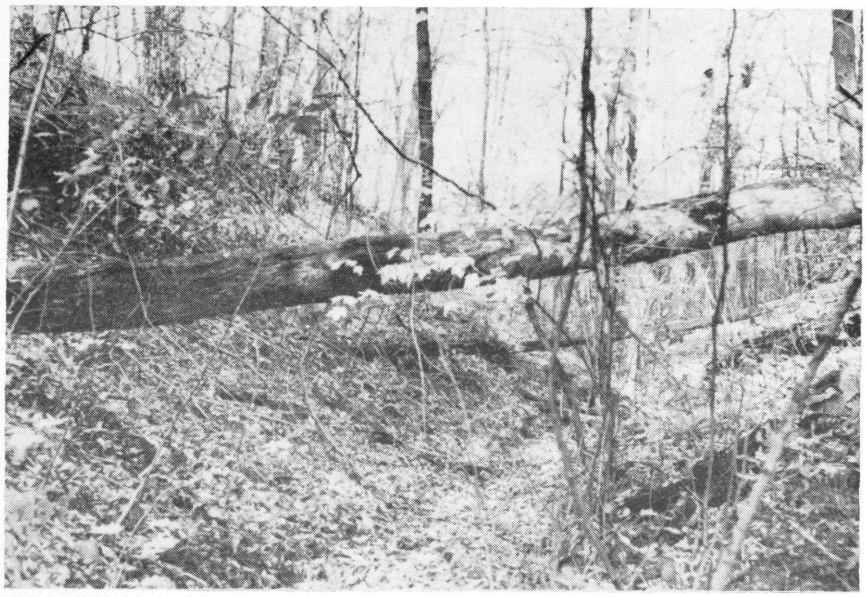

FIGURE 7. Log suspended across ravine. Typical hibernation site of *Aoplus confirmatus* and *Stenichneumon culpator cincticornis*.

decayed wood, was found in a wide array of sites, including positions under the bark of stumps and standing trees, in insect burrows in logs, beneath moss on rocks and logs, and in crevices in larger rocks. *Ichneumon centrator*, the second most frequently collected species, was much more limited in its choice of hibernacula, being found most commonly under rather tightly adhering bark of logs either lying flat on the ground or suspended between the banks of deep ravines.

For most (37 species) of the hibernating species, individuals were found beneath the bark of fallen logs, where the bark had loosened sufficiently to enable the wasps to climb through openings into the space between the bark and the wood, providing them with protection both from predators and from dehydration. Logs of this type constitute two distinct types of hibernacula, based on the ichneumonid species found in them, those lying flat on the ground and those suspended across opposing banks of ravines. Individuals found on suspended logs tended to be congregated behind the bark on the lower surface of the logs; those that occurred on logs lying flat on the ground were most abundant on the upper and lateral surfaces of the logs.

The next most-frequented types of hibernacula were old logs in which the wood had either become "punky" or, while still firm, had become extensively channeled with insect burrows. Species characterized by a red abdomen, such as *Ichneumon ultimus*, *I. heterocampae*, *I. laetus*, *I. subversatus*, and *I. inurbanus*, were most usually found in these sites.

*Hoplismenus morulus* was collected in clusters of 5–16 individuals beneath the loose bark either of standing dead trees or fallen logs suspended between the banks of ravines, where they were concentrated on the lower sides. *Theronia atalantae fulvescens* was found in clusters of 6–36 individuals in locations of the latter type.

Moss growing in a thick carpet on rocks or on the bark of fallen logs provided another much-frequented hibernaculum. Species characteristic of this type of site included our smallest hibernating species, *Ichneumon pumiliops;* several black-winged red-abdomen species, *Ichneumon grandisops*, *I. heterodon*, *I. inurbanus*,

and *I. devinctor;* and the two hyaline-winged, red-abdomen species, *Ichneumon anonymus* and *I. annulatorius.*

Seyrig (1924) and Hancock (1923, 1925) were successful in locating many species in grass tussocks, but no success was realized in searches of this type of habitat in this study.

## SPECIES DISTRIBUTION AND ECOLOGICAL DATA

A total of 4,775 specimens was collected from hibernating sites and brought back to the laboratory for identification. Of these, 4,074 were taken in Ohio and 701 in western New York and southeastern Michigan. Five species were found in these neighboring states that have not been found in hibernation in Ohio. These species are noted in this paper and included in the key because of the considerable likelihood that they eventually will be found in Ohio. Approximately 500 additional specimens were identified in the field and released.

The relative numerical abundance of the species collected is shown in Table 1. Figure 1 and Table 2 show the localities at which collections were made, while Table 3 is a checklist of the hibernating species and the localities where each was collected. In this study, the species were more abundant, both in total numbers of individuals and numbers of species collected, in the hilly regions of southeastern Ohio than in the flatter terrain of the northern and western portions of the state. Hibernating ichneumonids were also usually unevenly distributed within a collection locality, with the majority of individuals occurring in only one or a few hibernacula in any single ravine or other favorable site, but absent from the remainder of the woodlot or adjacent ravines.

TABLE 1

*Totals of species collected and summary of habitat preferences*

| Species | Numbers Collected | | | Habitat Preferences in Order of Numbers Collected | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Ohio | Southern Michigan | Western New York | A | B | C | D | E | F |
| *Aoplus confirmatus* | 491+ | 71 | 40 | | 2 | 4 | 3 | 5 | 1 |
| *Aoplus p. permutabilis* | 71 | 17 | | | 1 | | | | 2 |
| *Aoplus p. leucorbis* | 7 | | | | 2 | 1 | | | |
| *Chasmias scelestus* | 45 | 30 | 4 | | 2 | 3 | 4 | | 1 |
| *Diphyus bizonatus* | *1 | | | | | | | | |
| *Diphyus distinctipes* | *1 | | | | | | | | |
| *Eutanyacra hiemans* | 13 | | | | | 1 | | | |
| *Hoplismenus m. morulus* | 168 | | | 1 | 3 | | | | 2 |
| *Ichneumon annulatorius* | 22 | | 2 | 4 | 3 | | | 1 | 2 |
| *Ichneumon anonymus* | 53 | 8 | 1 | | 2 | 3 | | 1 | 4 |
| *Ichneumon caliginosus* | | 1 | 1 | | 1 | | | | |
| *Ichneumon canadicola* | 25 | | | | 1 | | | 2 | |
| *Ichneumon centrator* | 534+ | 5 | 37 | | 1 | | | | 2 |
| *Ichneumon chasmodops* | | | 1 | | | | | | |
| *Ichneumon creperus* | 3 | | | | | 2 | | 1 | |
| *Ichneumon devinctor* | 14 | | 2 | | 2 | | 4 | 1 | 3 |
| *Ichneumon fuscifrons* | 181 | 14 | | | 2 | | 3 | 4 | 1 |
| *Ichneumon grandisops* | 66 | | | | | 3 | 4 | 1 | 2 |
| *Ichneumon heterocampae* | 468+ | 20 | 23 | | | 1 | 2 | 3 | 4 |
| *Ichneumon heterodon* | 19 | | | | 3 | | | 1 | 2 |
| *Ichneumon inurbanus* | 22 | | | | | 1 | 3 | 2 | |
| *Ichneumon laetus* | 33 | | | | | 1 | 2 | 3 | 4 |
| *Ichneumon mendax* | 110 | 71 | 4 | | 1 | | 4 | 3 | 2 |
| *Ichneumon nereni emigrator* | 1 | | | | | | | | 1 |
| *Ichneumon pumiliops* | 327+ | | | | 2 | | | 1 | 3 |
| *Ichneumon putus* | 4 | | | | 1 | | | | |
| *Ichneumon stagniphilos* | | | 4 | | 1 | | | | |
| *Ichneumon substituens* | 1 | | | | 1 | | | | |
| *Ichneumon subversatus* | 50 | | | | 3 | 1 | | 2 | |
| *Ichneumon trizonatus* | | 6 | | | 1 | | | | |
| *Ichneumon ultimus* | 732+ | 146 | 12 | 4 | 5 | 1 | 2 | 3 | 6 |

TABLE 1—*Continued*

| Species | Numbers Collected | | | Habitat Preferences in Order of Numbers Collected | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Ohio | Southern Michigan | Western New York | A | B | C | D | E | F |
| *Ichneumon versabilis* | 4 | | | | 2 | | | | 1 |
| *Ichneumon vivax* | 26 | | | | | | | | 1 |
| *Ichneumon winkleyi* | 9 | | | | 3 | 1 | | | 2 |
| *Ichneumon zelotypus* | 1 | | | | | | | 1 | |
| *Ichneumon* n. sp. | 3 | | | | 1 | | | | |
| *Orgichneumon calcatorius* | 118+ | | | | 2 | | 3 | | 1 |
| *Patrocloides perluctuosus* | 7 | | 1 | | 1 | | | | 2 |
| *Rhembobius a. abdominalis* | 1 | | | | 1 | | | | |
| *Rubicundiella mucronata* ♂ | | 1 | | | 1 | | | | |
| *Stenichneumon culpator cincticornis* | 272+ | 78 | 64 | | 2 | 4 | 3 | | 1 |
| *Theronia atalantae fulvescens* | 58 | | | | | | | | 1 |
| *Thyrateles caliginops* | 3 | 13 | 2 | | | 1 | | | 2 |
| *Thyrateles instabilis* | 90 | 18 | | | 2 | 3 | | | 1 |
| *Thyrateles lugubrator* | 20 | 3 | | | 2 | | | | 1 |

*Taken in flight in January and February.
+Additional specimens released in the field.
Habitat preferences
A. Under loose bark of standing trees.
B. Between bark and firm wood of fallen logs or stumps.
C. In punky, well-decayed wood.
D. In insect burrows of fallen logs.
E. Under moss on fallen logs or rocks.
F. Under bark of logs suspended across ravines.
Order of abundance of specimens—1, 2, 3, etc.

TABLE 2

*Collection localities and map reference numbers*

1. John Bryan State Park, Greene Co.
2. Rocky Fork State Park, Highland Co.
3. Pike Lake State Park, Pike Co.
4. Scioto Trail State Park, Ross Co.
5. Forked Run State Park, Meigs Co.
6. Hocking Hills State Park, Hocking Co.
7. Burr Oak State Park, Athens Co.
8. I mile S.E. of Jacksontown, Licking Co.
9. Dillon Reservoir State Park, Muskingum Co.
10. 6 miles west of New Concord, Muskingum Co.
11. Norwich, Muskingum Co.
12. 4 miles west of New Concord, Muskingum Co.
13. New Concord Reservoir, Muskingum Co.
14. New Concord, Muskingum Co.
15. 1 mile S.E. of New Concord, Muskingum Co.
16. Blue Rock State Park, Muskingum Co.
17. Wills Creek Reservoir, Coshocton Co.
18. Salt Fork State Park, Guernsey Co.
19. Seneca Lake State Park, Noble Co.
20. 4 miles S.E. of Woodsfield, Monroe Co.
21. Barkcamp State Park, Belmont Co.
22. 2 miles S.W. of Hendrysburg, Belmont Co.
23. Piedmont Lake, Harrison Co.
24. Steubenville, Jefferson Co.
25. Jefferson State Park, Jefferson Co.
26. Mohican State Park, Ashland Co.
27. Findley State Park, Lorain Co.
28. 4 miles east of Oberlin, Lorain Co.

Ten species were collected in 15 or more of the 28 collection localities. *Ichneumon centrator* was taken in 23 of the 28 localities, *Ichneumon ultimus* and *Stenichneumon culpator cincticornis* in 21, *I. pumiliops* in 19, *I. mendax* and *Aoplus confirmatus* in 18, *I. heterocampae* in 17, and *I. anonymus*, *I. grandisops*, and *Hoplismenus m. morulus* in 15. *Ichneumon ultimus*, one of the clustering species, was the most abundant in number of individuals collected in this study. *Ichneumon centrator*, a species that tends to hibernate singly or in very limited numbers, ranked second in number of individuals collected, followed by *Ichneumon heterocampae* and *Aoplus confirmatus*, two other clustering species. Among the less frequently collected species, 14 of the 39 species found hibernating in Ohio were quite rare, a total of five or fewer specimens having been collected during the entire study.

A sharp reduction in the numbers of individuals collected was noted in Ashland, Coshocton, and Muskingum Counties during the 1969–70 winter. This may be a result of the spraying of insecticide for mosquito control applied by airplane during the late summer of 1969. In contrast, the number of specimens collected in Guernsey County, which borders Muskingum County but which was not sprayed during the summer of 1969, was normal during the 1969–70 winter.

## KEY TO THE HIBERNATING ICHNEUMONIDAE OF OHIO

The following taxonomic key to the hibernating species of Ichneumonidae of Ohio includes the thirty-nine species collected in Ohio plus the five species collected only in southeastern Michigan and western New York. The key is based on the collected material. The extreme variability of color in several species has necessitated the use of antennal characteristics which may require a bit of experience before proper interpretation can be assured. Heinrich's (1960–1962) keys to the Ichneumoninae of northeastern United States have been helpful in organizing this key. The taxonomic relationships among the forty-four species included in the key include the following: *Rhembobius a. abdominalis* of the Subfamily Gelinae; *Theronia atalantae fulvescens* of the Subfamily Ephialtinae; and forty-two species in eleven genera of the Subfamily Ichneumoninae.

1. Ovipositor longer than hind tibia; white flagellar annulus lacking; spatulate bristle extending from base to apex of tarsal claw..... *Theronia atalantae fulvescens* (Cresson)
   Ovipositor shorter than hind tibia; white flagellar annulus usually present; spatulate bristle lacking on tarsal claw..... 2
2. Ovipositor longer than petiole length; sternaulus deeply impressed on anterior half of mesopleurum; abdomen polished and impunctate
   *Rhembobius a. abdominalis* (Provancher)
   Ovipositor shorter than petiole length; sternaulus shallow or lacking; abdomen variously sculptured and punctate..... 3
3. Abdomen predominantly black or blue-black..... 4
   Abdomen predominantly red or orange..... 12
4. White anal spot present on abdominal tergites 6 and 7; apical margin of clypeus sinuous; median field of postpetiole polished and sparsely punctate apically
   *Chasmias scelestus* (Cresson)
   White anal spot lacking; apical margin of clypeus trunctate; median field of postpetiole striate or mat..... 5
5. Hind coxa bearing a large subapical tubercle on the median side
   *Stenichneumon culpator cincticornis* (Cresson)
   Hind coxa lacking a subapical tubercle..... 6
6. Propodeum bearing a prominent postero-lateral protuberance; scutellum conical; tibiae and tarsi of all legs orange..... *Holismenus morulus morulus* (Say)
   Propodeum lacking a prominent postero-lateral protuberance; scutellum more flattened; tibiae and/or tarsi infuscate..... 7
7. Hind tibia entirely black..... 8
   Hind tibia marked with white or yellow medially..... 10
8. Wings heavily infuscate..... *Ichneumon caliginosus* Cresson
   Wings hyaline or lightly infuscate..... 9
9. White markings present on facial inner orbits and on dorsal margin of pronotal lobe; apical flagellar segments flattened ventrally, not tapered apically and not ending in blunt apex..... *Ichneumon mendax* Cresson
   White markings lacking on facial inner orbits and on dorsal margin of pronotal lobe; apical flagellar segments not flattened ventrally, finely tapered to acute apex
   *Thyrateles caliginops* Heinrich
10. Wings heavily infuscate; scutellum red; facial margins red or black; mesoscutum usually partially red..... *Ichneumon centrator* Say
    Wings hyaline; scutellum white; facial margins white; mesoscutum black..... 11

TABLE 3

*Checklist of Ohio species of hibernating Ichneumonidae and collection localities*

| Species | Collection locality reference numbers | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 |
| *Aoplus confirmatus* | X | | | X | X | | X | X | | X | | X | X |
| *Aoplus p. permutabilis* | | | | | | | | | | | | X | |
| *Aoplus p. leucorbis* | | | | | X | | | X | | | | | X |
| *Chasmias scelestus* | X | | | | | | | X | | X | X | X | |
| *Diphyus bizonatus* | | | | | | | | | | | | | |
| *Diphyus distinctipes* | | | | | | | | | | | | | |
| *Eutanyacra hiemans* | | | | | X | | X | | | | | X | X |
| *Hoplismenus m. morulus* | X | | X | | | X | | | | | X | X | X |
| *Ichneumon annulatorius* | | | | | X | | | | | | | X | X |
| *Ichneumon anonymus* | | | | | X | | X | X | | | | X | X |
| *Ichneumon canadicola* | | | | | | | | | | | X | | X |
| *Ichneumon centrator* | X | | | | X | X | X | | X | X | X | X | X |
| *Ichneumon creperus* | | | | | | | | | | | | | X |
| *Ichneumon devinctor* | | | | | | X | | | | | X | | |
| *Ichneumon fuscifrons* | X | | | X | | X | X | | | X | X | | |
| *Ichneumon grandisops* | | | | | | X | | X | | X | X | X | X |
| *Ichneumon heterocampae* | | | | X | X | X | X | | | X | X | X | X |
| *Ichneumon heterodon* | | | | | | | | | | | | X | X |
| *Ichneumon inurbanus* | | | | | X | | | | | | | X | X |
| *Ichneumon laetus* | X | | | | | | | | | | | X | X |
| *Ichneumon mendax* | X | | | | | X | | X | | X | X | X | X |
| *Ichneumon nereni emigrator* | | | | | | | | | | | | | |
| *Ichneumon pumiliops* | | X | | X | | X | | X | | X | X | X | X |
| *Ichneumon putus* | | | | | | | | | | | | | X |
| *Ichneumon substituens* | | | | | | | | | | | | | |
| *Ichneumon subversatus* | | | | | | | | | | X | X | X | X |
| *Ichneumon ultimus* | | | | X | X | X | X | | X | X | X | X | X |
| *Ichneumon versabilis* | | | | | | | | | | | | | |
| *Ichneumon vivax* | | | | X | | | | | | | | | |
| *Ichneumon winkleyi* | | | | | | | | | | X | X | | X |
| *Ichneumon zelotypus* | | | | | | | | | | | | | |
| *Ichneumon* n. sp. | | | | | | | | | | | | | X |
| *Orgichneumon calcatorius* | X | | X | X | | X | X | | | | X | X | |
| *Patrocloides perluctuosus* | | | | | | | | | | | | | |
| *Rhembobius a. abdominalis* | | | | | | | | | | | | | |
| *Stenichneumon culpator cincticornis* | X | | | X | | X | X | X | | X | X | X | X |
| *Theronia atalantae fulvescens* | | | | | | | | | | | | | |
| *Thyrateles caliginops* | | | | | | | | X | | | | | |
| *Thyrateles instabilis* | | | | | | | | X | | | | X | X |
| *Thyrateles lugubrator* | | | | X | | | | | | | | X | X |

11. Abdomen blue-black; flagellar segments not flattened ventrally on apical half of flagellum; petiole lacking white apical spot; white median band of hind tibia complete ..... *Patrocloides perluctuosus* (Provancher)

    Abdomen black; flagellar segments flattened ventrally on apical half of flagellum; petiole with small white apical spot; white median band of hind tibia interrupted anteriorly ..... *Orgichneumon calcatorius* (Thunberg)

12. Scutellum laterally carinate to middle; propodeum bearing a strong postero-lateral protuberance ..... *Rubicundiella mucronata* (Provancher)

    Scutellum not laterally carinate to middle; propodeum with small or no postero-lateral protuberance ..... 13

13. Wings heavily infuscate ..... 14

    Wings hyaline or lightly infuscate ..... 19

14. Hind tibia banded with black at base and apex, white banded medially ..... *Ichneumon devinctor* Say

    Hind tibia not black and white banded ..... 15

TABLE 3

*Checklist of Ohio species of hibernating Ichneumonidae and collection localities*

| | Collection locality reference numbers | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 |
| X | X | X | X | | X | | X | X | X | | X | X | | |
| X | X | | X | | X | | X | | | | X | X | | |
| | | X | X | | | | | | | | | | | |
| X | X | X | X | X | X | | X | | | | | X | | |
| X | | | | | | | | | | | | | | |
| X | | | | | | | | | | | | | | |
| | | | | | X | | | | | | | | | |
| X | X | | X | X | X | | X | X | X | | | X | | |
| | | | X | X | X | | | X | | | | X | | |
| X | X | X | X | | X | | X | | X | | | X | X | X |
| | | X | X | | | | | X | X | | | X | | |
| X | X | X | X | X | X | X | X | X | X | X | X | X | X | |
| | | | X | X | | | | | X | | | X | | |
| | X | X | X | | X | | X | | X | | | X | | |
| X | X | X | X | | X | | X | | X | | X | X | | |
| X | X | X | X | | X | | X | X | X | | X | X | | |
| | X | X | X | | | | | X | | | | X | | |
| | X | X | X | | X | | X | X | | | | X | | |
| | | X | | | | | | | X | | | | | |
| X | X | X | X | X | X | X | X | X | X | | X | X | | X |
| | X | | | | X | | X | X | | | | X | | |
| | | | | | | | | | | | | X | | |
| X | X | | X | | X | | X | | | | | X | | |
| | X | | | | | | X | | | | | X | | |

15. Mandible strongly punctate, teeth subequal in length; face mat between punctures
*Ichneumon heterodon* Heinrich

Mandible less punctate, dorsal tooth noticeably longer than ventral tooth; face polished between punctures ..... 16

16. Ovipositor sheath not extending beyond abdominal apex in dorsal view; flagellar segments not flattened ventrally beyond middle of flagellum; hind femur closely punctate dorsolaterally ..... *Thyrateles lugubrator* (Gravenhorst)

Ovipositor sheath extending beyond abdominal apex in dorsal view; flagellar segments flattened ventrally beyond middle of flagellum; hind femur sparsely punctate dorsolaterally ..... 17

17. Lower tooth of mandible minute; flagellum rather blunt at apex
*Ichneumon inurbanus* Cresson

Lower tooth of mandible not reduced; flagellum tapered to acute apex ..... 18

18. Hind tibia black; scutellum strongly elevated above level of postscutellum, usually black; flagellar segments strongly flattened ventrally and widened beyond middle of flagellum ..... *Ichneumon grandisops* Heinrich

Hind tibia red-brown before apex; scutellum flattened, white; flagellar segments slender, only slightly flattened ventrally and not widened beyond middle of flagellum
*Ichneumon zelotypus* Cresson

19. Median field of postpetiole finely coriaceous or smooth; legs orange....20
Median field of postpetiole finely striate; legs orange or red and/or black....21

20. Mesoscutum largely blackened; more than 11 mm in length; tip of abdomen and apex of hind femur not infuscate....*Aoplus confirmatus* (Cresson)
Mesoscutum largely ferruginous; less than 10 mm in length; tip of abdomen and apex of hind femur infuscate....*Aoplus permutabilis* Heinrich

21. Head, thorax, and coxae black with extensive yellow markings; abdomen orange with yellow apical corners on segments 1–3 and on anal spot; mesoscutum mat between punctures....*Ichneumon fuscifrons* Cresson
Head, thorax, coxae, and abdomen black and/or rufous but not marked extensively with yellow; mesoscutum polished between punctures....22

22. Small species, 5–6 mm in length; legs orange-red, infuscate at apex of hind femur and tibia; head and thoracic pleura and sterna black....*Ichneumon pumiliops* Heinrich
Larger species, 7 mm or more in length; color pattern not as above....23

23. Abdomen with yellow basal bands or spots on segments 2 and 3, remainder variably marked with red and black; hind tibia yellow on median 0.7 with basal and apical infuscation; ovipositor sheath not extending beyond tip of abdomen
*Diphyus bizonatus* (Cresson)
Abdomen lacking yellow basal bands or spots on segments 2 and 3; hind tibia not yellow on median 0.7; ovipositor sheath usually extending beyond tip of abdomen....24

24. Yellow or white anal spot on segment 7, or on both 6 and 7....25
Yellow or white anal spot lacking (*annulatorius* varies in this characteristic and keys out from both halves of this couplet)....33

25. Predominantly rufous on head and thorax; smaller species, 7–9 mm in length....26
Predominantly black on head and thorax; mostly larger species, 8–11 mm in length..27

26. Abdomen black beyond segment 4; antenna lacking white annulus
*Ichneumon putus* Cresson
Abdomen entirely red; antenna bearing white annulus
*Ichneumon substituens* Heinrich

27. Abdomen black beyond segment 3....28
Abdomen red beyond segment 3....29

28. Head black; hind tibia reddish-brown with apical infuscation; antenna reddish-brown on basal half, tapered apically and ending in acute tip; mesoscutum and postpetiole black....*Ichneumon nereni emigrator* Heinrich
Head extensively marked with rufous; hind tibia medially yellowish; antenna black on basal half before white annulus, parallel-margined and ending in blunt tip; mesoscutum and postpetiole rufous....*Ichneumon chasmodops* Heinrich

29. Hind coxa sparsely punctate and sparsely pubescent ventrally; subtegular ridge black
*Ichneumon annulatorius* Fabricius
Hind coxa densely punctate and heavily pubescent; subtegular ridge yellow or rufous...30

30. Hind tibia yellow-banded medially; dense scopa (patch of dense hairs) on hind coxa ventrally....*Ichneumon ultimus* Cresson
Hind tibia rufous, or rufous and black; scopa lacking or sparse on hind coxa....31

31. Head predominantly rufous....*Ichneumon stagniphilos* Heinrich
Head black....32

32. Abdominal segment 2 slightly longer than wide; yellow anal mark on segment 7
*Ichneumon anonymus* Heinrich
Abdominal segment 2 distinctly wider than long; yellow anal mark on segments 6 and 7
*Ichneumon vivax* Cresson

33. Thorax, including scutellum, predominantly rufous; abdomen black at base of segments 3 and 4; hind femur infuscate except for rufous base....*Ichneumon creperus* Cresson
Thorax predominantly black, at most dusky-rufous on mesoscutum; scutellum white or yellow; abdomen not black at base of segments 3 and 4 (except in *Ichneumon laetus* and *Diphyus distinctipes*, but with the hind femur infuscate only at apex in these two species)....34

34. Hind tibia black at base and apex, yellow-banded medially with rufous area at each end between the black and yellow....35
Hind tibia variously marked with black and rufous, but not as above....36

35. Hind coxa with a dense tuft of pubescence (scopa) ventrally; head mostly black
*Ichneumon canadicola* Heinrich
Hind coxa sparsely pubescent ventrally; head extensively marked with rufous
*Ichneumon heterocampae* (Cushman)

36. Abdomen rounded or somewhat compressed at apex; ovipositor sheath not extending beyond apex of abdomen and not visible in dorsal view....37
Abdomen pointed at apex; ovipositor sheath more exposed and ordinarily visible beyond abdominal apex in dorsal view....39

37. Hind femur largely black; antennal flagellum bicolored.....*Eutanyacra hiemans* Heinrich
Hind femur rufous; antennal flagellum usually tricolored.....38
38. Gastrocoeli at base of abdominal segment 2 conspicuous, wider than interval between *Thyrateles instabilis* (Cresson)
Gastrocoeli small, narrower than interval between.....*Diphyus distinctipes* (Heinrich)
39. Distinct scopa (patch of dense hairs) present ventrally on hind coxa.....40
Distinct scopa absent.....41
40. Femora rufous, with only apex of hind femur infuscate; head mostly rufous; gastrocoeli narrower than interval between.....*Ichneumon laetus* Brullé
Femora and head mostly infuscate; gastrocoeli wider than interval between *Ichneumon versabilis* Cresson
41. Head, fore, and middle femora predominantly rufous.....*Ichneumon subversatus* Heinrich
Head, fore, and middle femora predominantly black.....42
42. Hind coxa sparsely punctate and polished on ventral side.....43
Hind coxa densely punctate and dull on ventral side.....44
43. Flagellum strongly tapered distally, ending in point; gastrocoeli large, subequal to interval between.....*Ichneumon* n. sp.
Flagellum little tapered distally, blunt at apex; gastrocoeli small, much narrower than interval between.....*Ichneumon annulatorius* Fabricius
44. Flagellum tricolored usually; lateral margin of scutellum rounded anteriorly; hind coxa coarsely punctate laterally before apex.....*Ichneumon winkleyi* (Viereck)
Flagellum bicolored; lateral margin of scutellum sharply angled anteriorly; hind coxa sparsely punctate laterally before apex.....*Ichneumon trizonatus* Provancher

## CONCLUSIONS

Ichneumonidae comprising thirty-nine species in thirteen genera and three subfamilies have been collected in hibernation in Ohio. Hibernation in Ohio extends from mid-October to mid-April. With one exception, all collected specimens were female. The kinds of hibernacula used by most species were limited and were characteristic for each species. The hibernacula used included sites beneath the bark of standing and fallen trees, within "punky" wood or in insect burrows, and under moss carpets on logs or rocks.

## ACKNOWLEDGMENTS

Most of the specimens were collected and identified by the author. Two Muskingum College graduates, Michael FitzSimmons and Richard Duffield, in partial fulfillment of graduation requirements in biology, collected some of the specimens in their senior research studies. Dr. Gerd Heinrich kindly checked the identifications of several species.

## LITERATURE CITED

**Hancock, G. L. R.** 1923. On some hibernating Ichneumonidae from the Cambridgeshire fens. Entomol. Mon. Mag. 59: 152–158.

**Hancock, G. L. R.** 1925. Notes on the hibernation of Ichneumonidae and on some parasites of *Tortrix viridana* L. Entomol. Mon. Mag. 61: 23–28.

**Heinrich, G. H.** 1960–62. Synopsis of Nearctic Ichneumoninae Stenopneusticae with particular reference to the northeast region. Parts 1–7. The Canad. Entomol. Suppl. 15, 18, 21, 23, 26, 27, and 29: 1–886.

**Peck, O.** 1964. Synopsis of Nearctic Ichneumoninae Stenopneusticae with particular reference to the northeast region. Mem. Entomol. Soc. Canada. Part 8. 35: 889–925.

**Raskitzyn, A. P.** 1960. Hibernation sites of ichneumon flies (Hymenoptera, Ichneumonidae). Entomol. Obosr. 38: 546–553.

**Seyrig, A.** 1924. Observations sur la biologie des ichneumons. Ann. Soc. Entomol. France (1923) 92: 345–362.

**Townes, H. K.** 1938. Ichneumon hibernation in the northeastern United States. (Hymenoptera, Ichneumonidae). Entomol. News 49: 219–221.